CS 340

UML Class Diagrams

A model is an abstraction of a system, specifying the modeled system from a certain viewpoint and at a certain level of abstraction

Complexity and Modeling

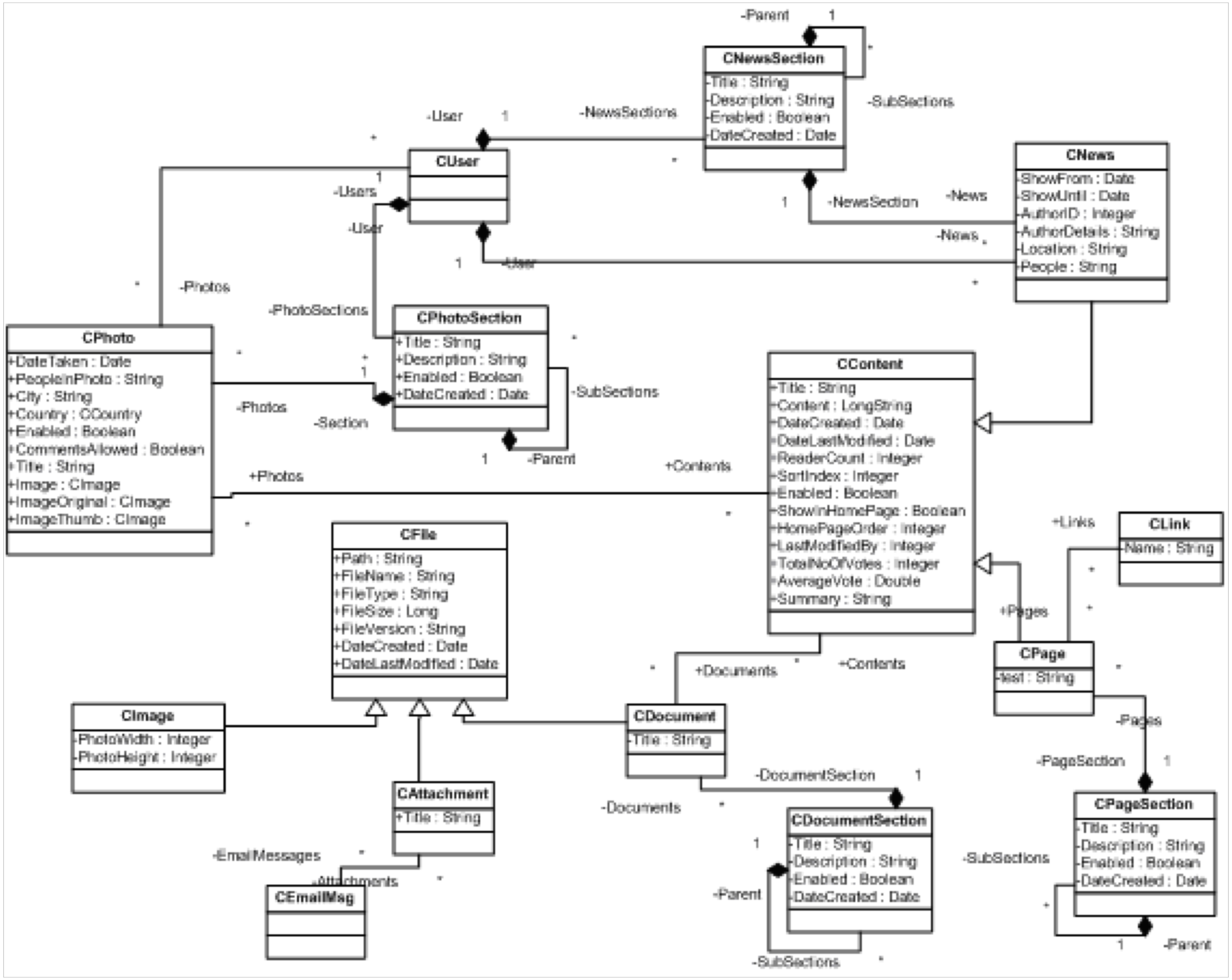
- Modeling is a well-accepted engineering technique for dealing with complexity
- Models let us focus on one view of the system while ignoring irrelevant details (a simplification of reality)
  - Example: Plumbers only care about plumbing, so we give them plumbing diagrams; electricians only care about electrical work, so we give them electrical diagrams, etc.
- Models can be created at different levels of abstraction
  - 10,000 ft. view vs. 10 ft. view
  - High-level: sketch of the building's exterior for the customer
  - Low-level: detailed electrical plan for the electrician

Software Modeling

- Why do we create models of software systems?
- Models help us visualize and understand the system we're building
- Models are used to document the design of the system and communicate it to others
- Models serve as a guide during system construction

UML

- Unified Modeling Language
- History
- Models
  - Data
  - Behavior
  - Interaction
  - Packaging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Levels of Models

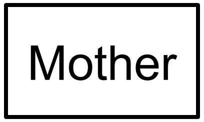
- Conceptual Model – Problem Understanding
- Specification/Requirement Document – Solutions
- High-Level Design Model
  - Systems, Packages, Classes
  - Interactions, Interfaces
- Low-Level Design Model
  - Class Conceptual Model
  - May be better done with Class documentation such as Javadoc
- Implementation
  - Should be done in code not UML

UML Models

- Structural/Data
  - **Class Diagram**
  - **Package Diagram** (a superset of class diagrams)
  - Object Diagram
- Behavior
  - Use Case Diagram
  - State Diagram
  - Activity Diagram
- Interaction
  - Communication Diagram
  - **Sequence Diagram**
- Physical Diagram
  - Component Diagram
  - Deployment Diagrams

Classes At the Conceptual Level

A Class – typically named with a common noun.



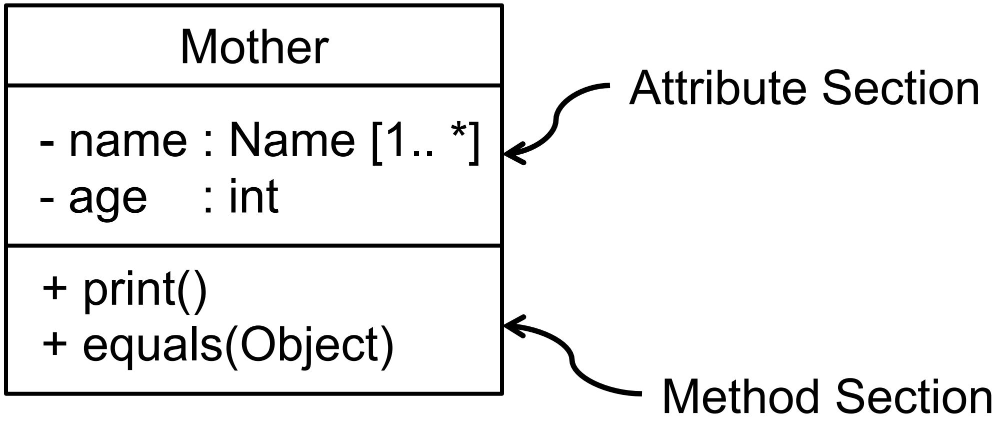
Mother

At the conceptual level the class is a set of objects with common properties.

Classes At the Design Level

A Class – typically named with a common noun.

At the design level a Class is a Type.



Mother

- name : Name [1.. *]
- age : int

+ print()
+ equals(Object)

Attribute Section

Method Section

Visibility constraints (optional) :

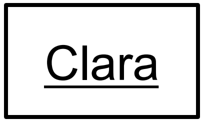
+ (public), - (private), # (protected), / (derived), _ (static), ~ (package).

We may add cardinality constraints to an attribute. In this case it means that a Mother has 1 or more names. If the cardinality constraint is omitted it is assumed to be the cardinality constraint “1”.

For some situations we may omit the Method Section or the Attribute Section.

Objects

An Object – notice the name is underlined.

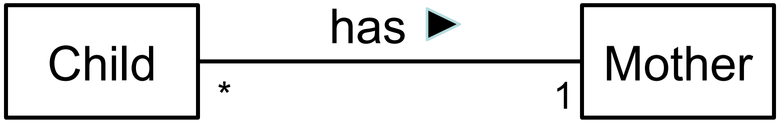


Clara

While some find Objects useful in the Class diagram others do not.

Associations

An association can be thought of as a declarative sentence.



The name in the association is optional but suggested.

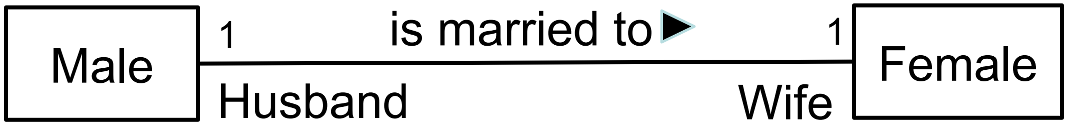
Typical association constraints are 1, 0..1, *, 1..*, n..m.

UML 1.0 supported a notation for an arbitrary set of non-negative integers (e.g. 2:4, 6,12 meaning the set {2,3,4,6,12}

Most associations are binary.

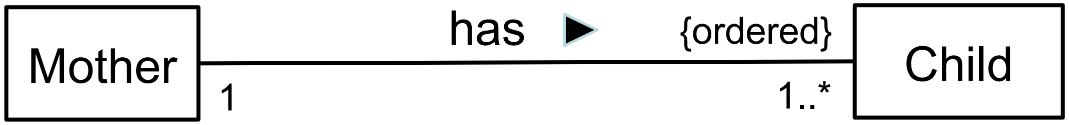
Associations Continued

- Roles



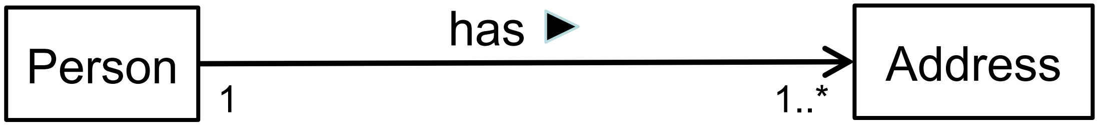
  - Although this example has 2 roles, there may be only 1, or most often 0 roles on an association.
  - Roles can be viewed as Specializations

- While not all versions of UML support the same annotations, you may find some when reading UML diagrams.

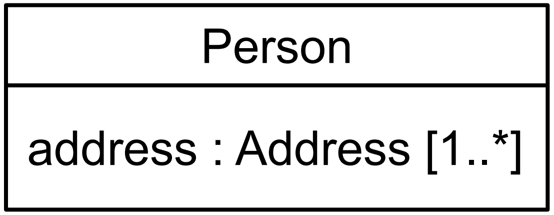


Directed Associations

- Should only be used as a design construct



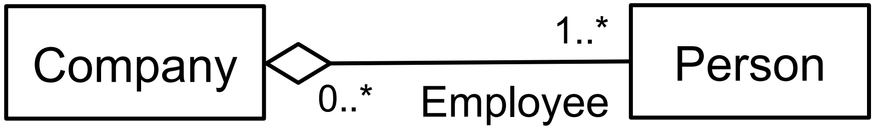
  - Means that we can access an Address via a Person, but, given an Address we can’t determine the Person associated with it.
  - If the association constraint on the opposite side of the navigability arrow is a 1, then this is equivalent to



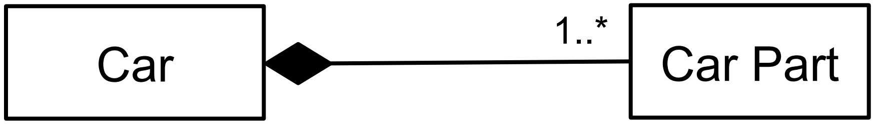
  - Notice the cardinality constraint to the right of the attribute.

Aggregation/Composition

- Aggregation

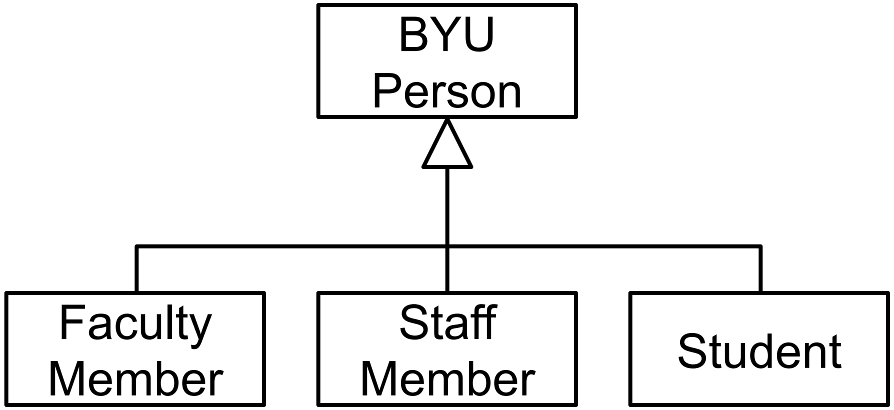


  - Can be read as Person is subpart of a Company
  - Some people prefer to just use associations
  - Can use “comb” representation if there are different types of subparts.
- Composition



  - Can be read as “A Car is composed of 1 or more Car Parts”.
  - A much stronger form of Aggregation. Some suggest it implies a Car Part cannot exist unless it is part of a car.
  - Notice there is no association constraint next to the black diamond because it is always 1.

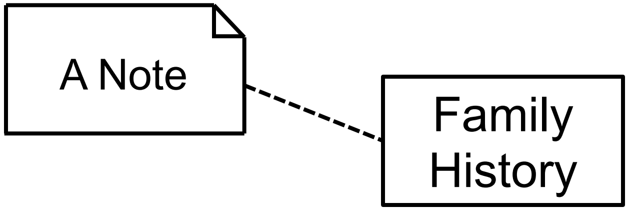
Generalization/Specialization



- For conceptual modeling every Faculty Member, Staff Member, and Student is a BYU Person. “Is A” Semantics. That is, subset semantics. In this case the set, Student, is a subset of the set BYU Person.
- At the Design level it represents “subtype” or “inheritance” semantics.
- A generalization/specialization often has a single specialization.

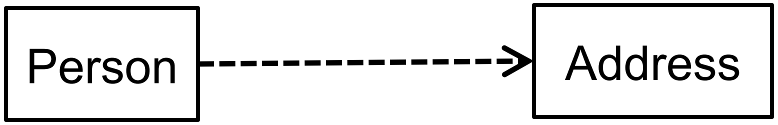
General Constraints/Notes

- General Constraints
  - {A Father must be a male Person}
  - Can be expressed formally in OCL, a type of first-order logic.
- Notes



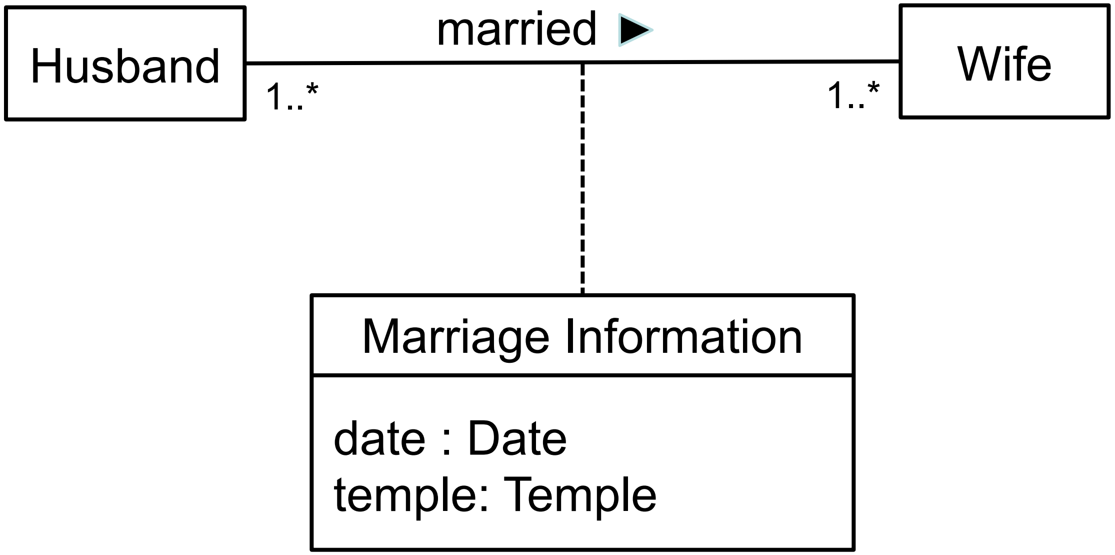
Dependency

- Used in design models. Especially good for representing dependencies that aren’t obvious, such as assumptions.

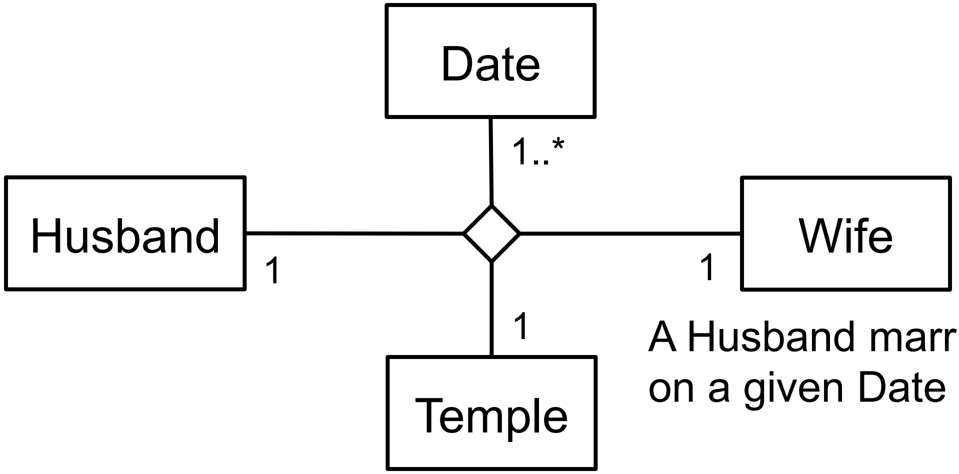


Association Class

- Useful when thinking of an association as an object.
- Could use an n-ary relation.

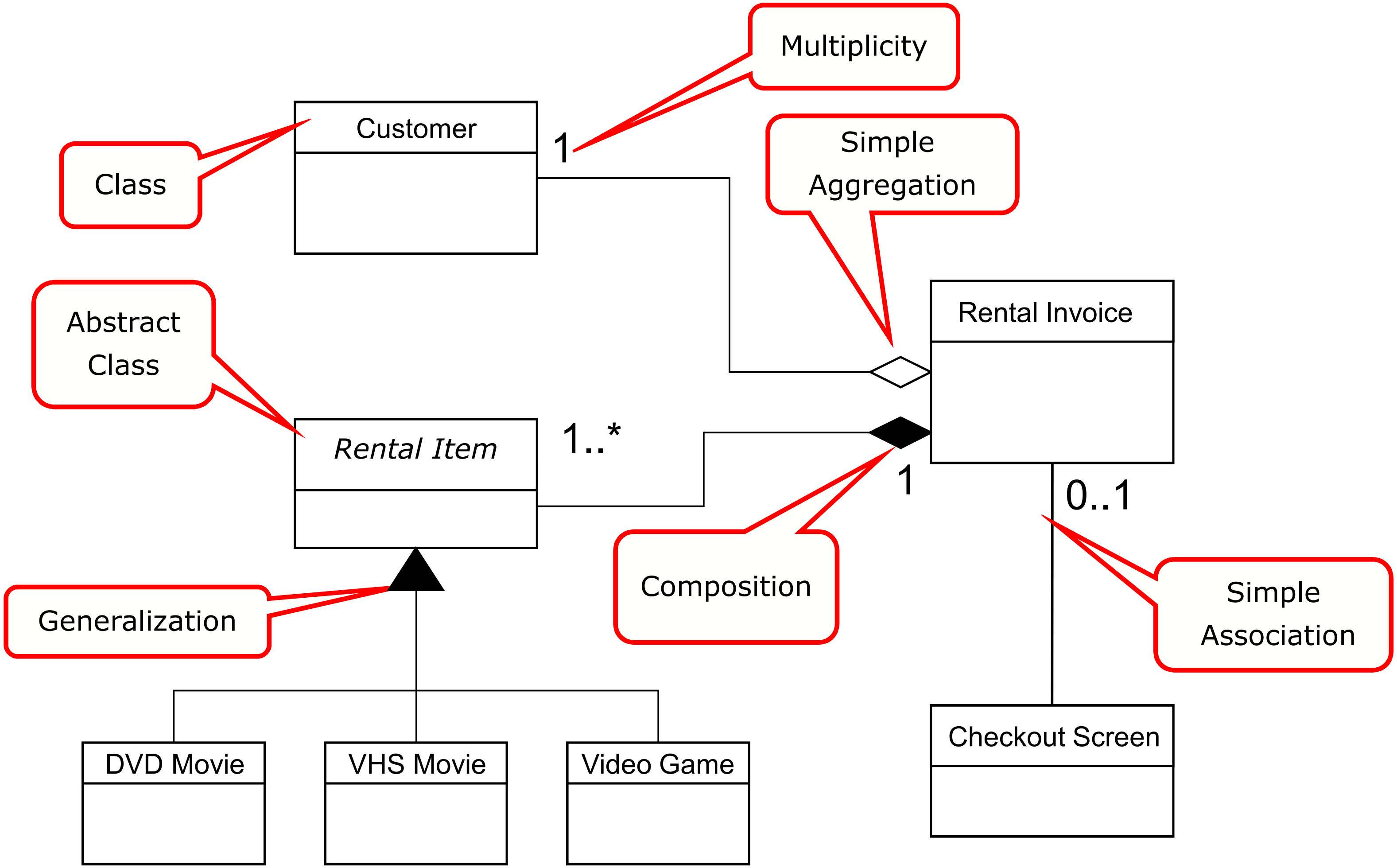


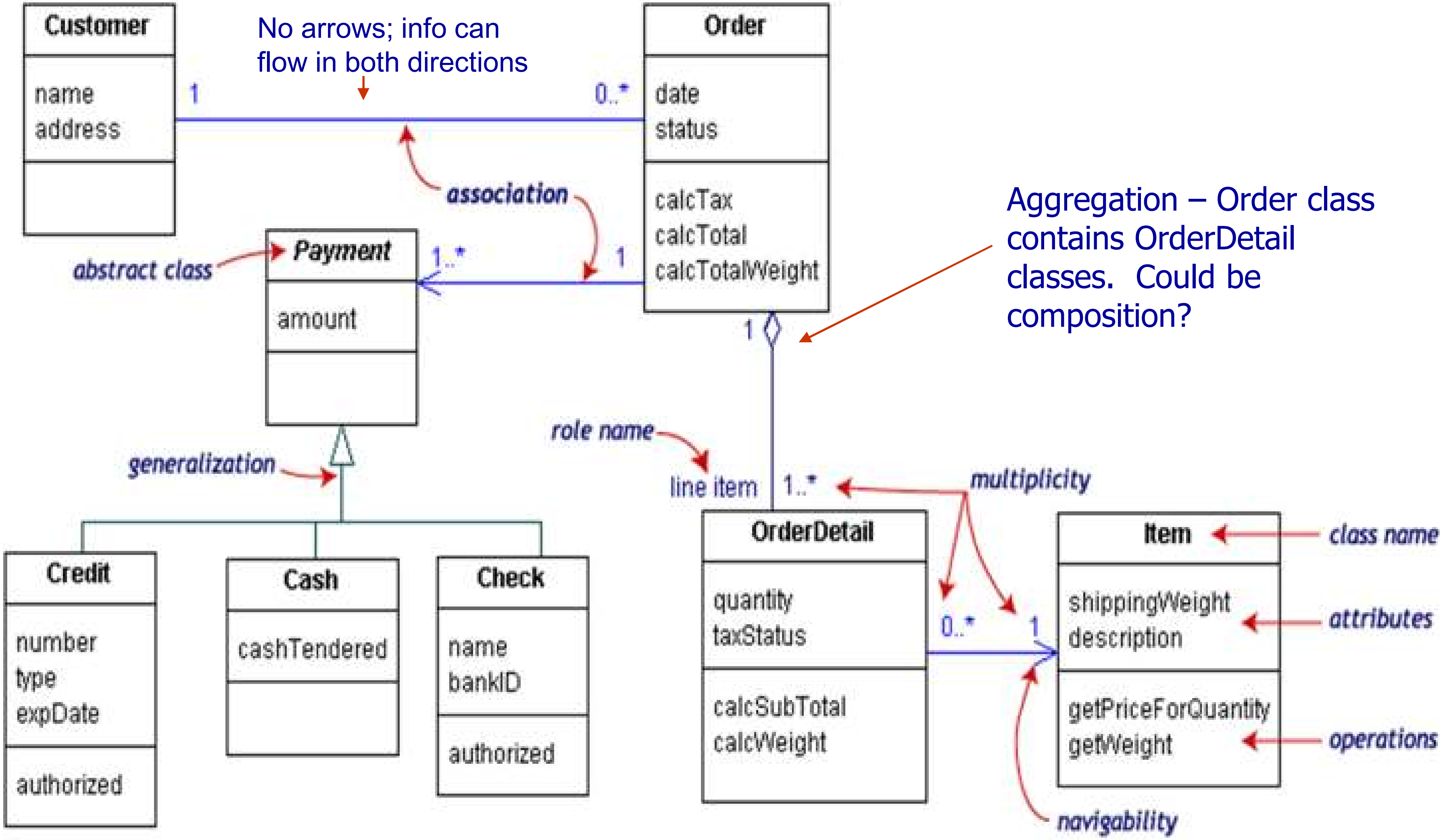
N-ary Associations



A Husband married a Wife
on a given Date at a particular Temple

- In UML the association constraints are binary functional dependencies.
- They tried to extend that idea to n-ary associations. It didn’t work well.
- Here the 4 association constraints mean
  - For a given Husband, Wife, and Temple in the association there are 1 or more Dates.
  - For a given Husband, Wife, and Date in the association there is 1 and only 1 Temple.
  - For a given Husband, Date and Temple in the association there is 1 and only 1 Wife.
  - For a given Wife, Date, and Temple in the association there is 1 and only 1 Husband.
- Because this is awkward it is not used much.


Multiplicity
Customer
1
Simple Aggregation
Class
Rental Invoice
Abstract Class
Rental Item
1..*
1
0..1
Composition
Simple Association
Generalization
DVD Movie
VHS Movie
Video Game
Checkout Screen

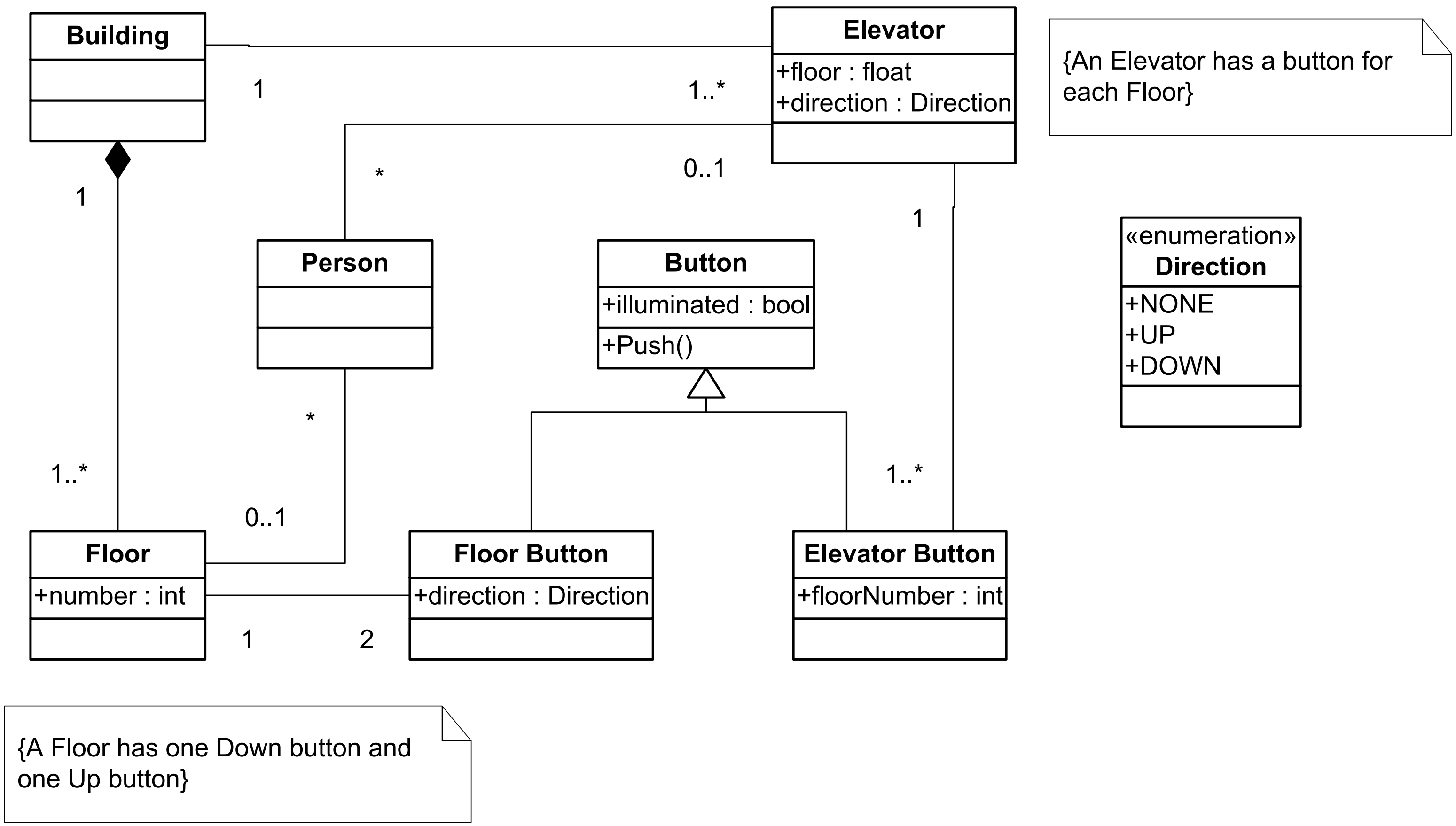


No arrows; info can flow in both directions

Aggregation – Order class contains OrderDetail classes. Could be composition?

Class Diagram Example

{A Person is always associated with a Floor
or an Elevator, but never both at the same time}



Building

Elevator
+floor : float
+direction : Direction

{An Elevator has a button for
each Floor}

Person

Button
+illuminated : bool
+Push()

«enumeration»
Direction
+NONE
+UP
+DOWN

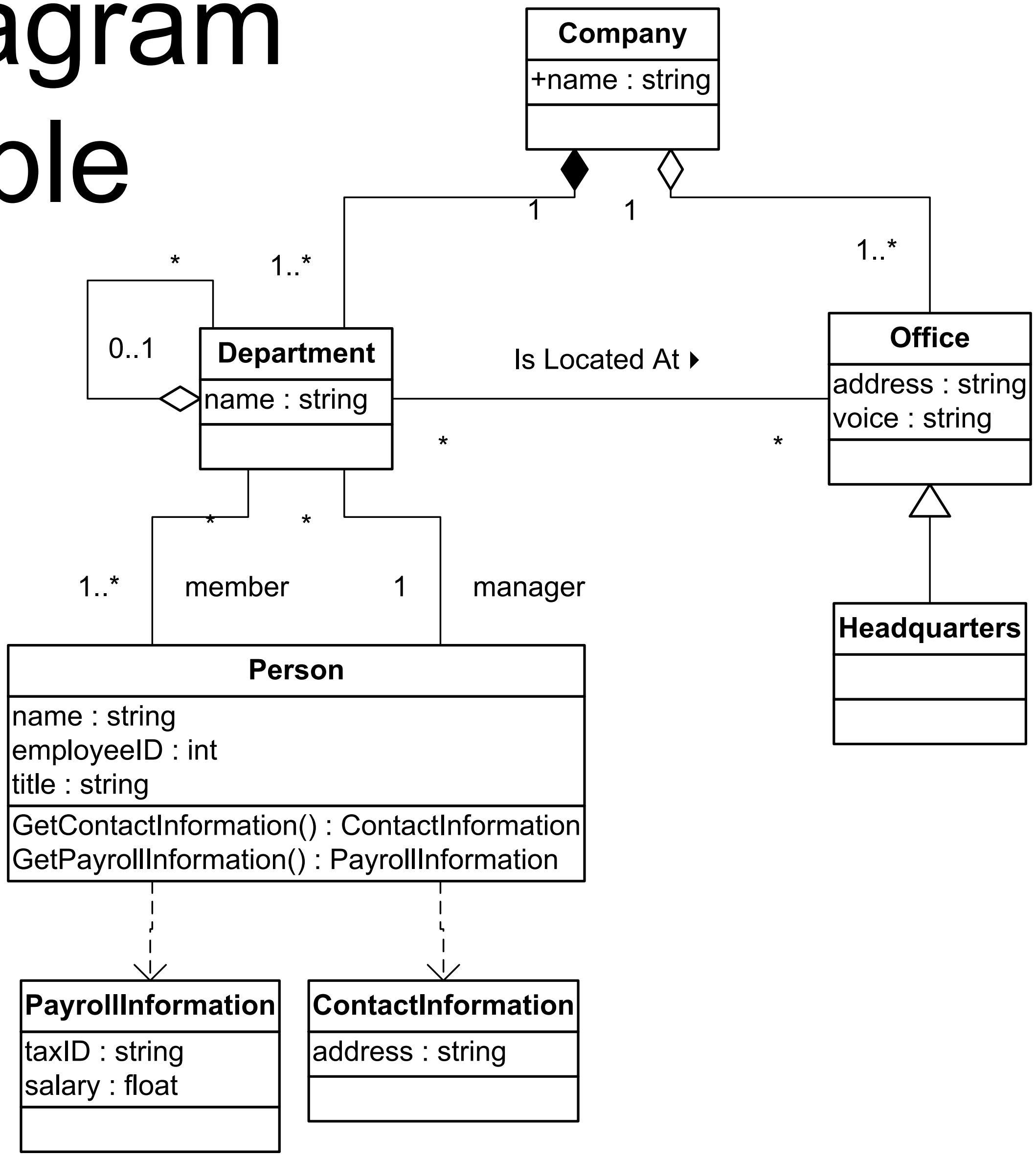
Floor
+number : int

Floor Button
+direction : Direction

Elevator Button
+floorNumber : int

{A Floor has one Down button and
one Up button}

Class Diagram Example



Source: Booch et. al., The UML User Guide